Notes on *Vallisneria* (Hydrocharitaceae) in Australia, with descriptions of two new species

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Abstract

Jacobs, S.W.L., and Frank, K.A. (Royal Botanic Gardens, Sydney, NSW 2000, Australia) 1997. Notes on Vallisneria *(Hydrocharitaceae) in Australia, with descriptions of two new species.* Telopea *7(2): 111–118.* Five species of *Vallisneria* are recognised from Australia, namely the cauline-leafed species *V. caulescens* and *V. triptera* and the non-cauline or tufted species *V. americana* (var. *americana*), *V. nana* and *V. annua*. Two of these, **Vallisneria triptera** and **Vallisneria annua**, are described here as new species from northern Australia, and an earlier name, *Vallisneria nana* R. Br., reinstated for a common Australian species. *V. gracilis* Bailey is recognised as a taxonomic synonym of *V. nana*, although many of the specimens previously identified as *V. gracilis* are now included in *V. annua*. Notes on all species and a key are given. The problems of comparing taxa growing in different countries and of applying correct names are discussed.

Introduction

The status of *Vallisneria* in Australia has been in some confusion since Bentham (1873) treated as one (*V. spiralis* L.) the two species, *V. spiralis* and *V. nana*, that Brown (1810) recognised. Den Hartog (1957) treated all Australian non-cauline plants as *V. gigantea* Graebner, basically a recognition that they were not *V. spiralis* s. str., whereas Aston (1973) considered that too little was known so opted to return to using the oldest name, *V. spiralis*.

Lowden (1982) published the first attempt to examine the genus from living populations from around the world. Unfortunately he did not visit Australia, which appears to be a centre of diversity for the genus, but he was able to recognise from the very minimal material that he saw that we have two different common non cauline-leaved species. These he referred to *V. americana* Michaux var. *americana* and *V. spiralis* var. *denseserrulata* Makino. Unfortunately, one of the characters that Lowden found most useful, the degree of filament adherence in the mature free-floating male flowers, is not readily discernible from most herbarium collections. It was also unfortunate that Lowden listed three 'unidentified taxa', *V. nana* R. Br., *V. caulescens* Bailey & F. Muell., and *V. gracilis* Bailey, all Australian.

One of us (SWLJ) has been collecting *Vallisneria* specimens for some years. Following Lowden's (1982) revision, we started making a special effort to collect mature fruit and the free-floating male flowers. The results of these field and specimen studies are presented here to provide new names and explain some of our decisions before a treatment is produced for *Flora of Australia*.

Discussion

As Lowden (1982) correctly points out, the only way to study species that are dioecious, soft, and difficult to preserve adequately, is to study populations in the field, preferably populations of both sexes, and to use a range of preservation

techniques. It is nearly impossible for one person to do this satisfactorily on a world-wide basis, especially for the apparently few taxa involved and the very large distribution of those taxa. It is a credit to Lowden that he was able to accomplish so much. He did not visit Australia and also didnot see duplicates of *Vallisneria canlescens*, which was rediscovered and recognised in the field by Roger Carolin and Surrey Jacobs (*Jacobs 1360, 1400, 1485, 1520*) in 1974. He therefore missed what we now show to be a centre of diversity for the genus and the recognition of the distinct cauline-leaved species that grow in Australia.

The matching of taxa from different countries is difficult enough with field work and good specimens. With the poor quality of many of the specimens of *Vallisneria*, especially older type specimens, identification becomes almost impossible using standard herbarium techniques. While we are confident about the taxa we have recognised, we echo Lowden (1982) in a lack of confidence in applying the earliest possible name, or even producing an accurate synonomy. The nomenclature is, at best, a compromise.

We have been able to examine many more specimens from Australia than Lowden was able to see, particularly the mature seeds and the free-floating male flowers. The seeds are embedded in mucilage which was removed by soaking in acetic acid (1:2 glacial acetic acid : water); they were then dried, coated and examined with an SEM. The free-floating male flowers were collected in 70% ethanol, dried, coated, and examined with an SEM. There is a problem in relating the free-floating flowers to the specimens collected from the rooted plants. In general the herbarium vouchers of rooted plants were collected as close as possible to, and upstream of, the floating flowers. Although more than one species may grow in any one river system, so far we have not found mixed populations (except for the two new species described here where distinction is not a problem), nor have we found such species growing in close proximity, but this is very difficult to check reliably.

For the one southern perennial species, identified both by Lowden (1982) and ourselves as *V. americana* var. *americana*, our observations agree with those of Lowden (1982). This species has the filaments in the male flower fused for about 75% of their length.

Our observations differ from Lowden's for the tropical and subtropical perennial species (identified by Lowden as *V. spiralis* var. *denseserrulata* and by us as *V. nana*) in which we found considerably more variation in the degree of fusion of the filaments than the basically free condition described by Lowden. In our material the filaments varied from almost free to having almost 75% of their length fused, and were most commonly somewhere between these extremes. The variation within a single sample ('specimen') was frequently as great as the total variation recorded.

Of the three facultative annual species, *V. triptera* has the filaments partly fused, whereas *V. canlescens* and *V. annua* have them free to, or almost to, the base.

There are two cauline-leaved species, *V. caulescens* and *V. triptera*. All the cauline-leaved specimens had been included in *V. canlescens*, presumably because of the obvious leaf character, despite the fact that Queensland specimens (plus one from the Northern Territory) of female plants have two perianth segments and the fruits flattened whereas most of the Northern Territory and all of the Western Australian female specimens had three perianth segments and three-winged fruits. These two cauline-leaved species are more different from each other than any of the rosette species are from each other.

V. annua is mostly an annual and has been collected from ephemeral habitats. In common with many annuals it produces numerous flowers and these can start appearing when the plant is very small. It has long-acuminate leaf tips and the female

flowers are usually smaller than those of the other tufted species, *V. nana*, that may grow in the same general area in more perennial water bodies.

The characters

Leaf tip: useful for distinguishing the tufted species if examined on a population basis. *V. annua* has long-acute leaf tips, *V. nana* has acute (rarely obtuse) leaf tips and *V. americana* has obtuse leaf tips. The cauline-leaved species both have acute to obtuse tips.

Leaf margin: each species has a characteristic margin though the differences are slight and difficult to convey in words. The margins of all species are serrulate to some degree. It is best to use several determined specimens for comparison if sterile specimens need to be identified. In *V. americana* the serrulations usually have an obvious basal cell or multi-celled base whereas *V. nana* mostly has serrulations with no obvious base. *V. annua* has smaller and sparser serrulations than the other rosette species. In *V. caulescens* the margin is usually almost straight, the serrulations jutting out from an otherwise almost straight margin; in *V. triptera* the serrulations are usually more forward-pointing with the margins slightly sinuous and coming in slightly after each serrulation.

Leaf nervation: not really useful, directly related to leaf size. The largest-growing species, *V. americana* normally has 5–7 major vascular strands but depauperate specimens may have 3. The normal condition in *V. nana* is 3, and in *V. annua* it is 1–3. In the cauline-leaved species, *V. triptera* generally has more nerves (5–7) than *V. caulescens* (3).

Seeds: while at first seeming a useful character the variation in seed surfaces is sufficiently great to make it difficult to detect any pattern in this variation. The only comments we can make are that:

(i) the two cauline-leaved species have a reticulate seed surface of almost circular to hexagonal cells and are free of projections; and (ii) the three tufted species have the epidermal cells longer than wide and tubercles or spines of various lengths and thicknesses; on any seed or in any one fruit the tubercles are similar but there seems to be substantial variation between populations. We have been unable to detect any taxonomically-correlated pattern in this variation.

Mature fruit: a useful character although mature fruit can be difficult to find in the perennial species, apparently owing to a combination of habitat conditions and predation. Fruit is easily found in the annual species. Mature fruit has dark grey to black seeds. Fruits of the three rosette species are cylindrical; *V. americana* fruit is almost the size of a slender pencil up to 5 mm wide and to 16 cm long (3–5 × 40–160 mm); the fruit of *V. nana* is generally smaller, to 3 mm wide by <10 cm long (2–3 × 20–90 mm); *V. annua* to 2 mm wide, 3.5 cm long (1.5–2 × 18–35 mm); *V. caulescens* has flattened 2-winged fruits to 5 mm wide and 10 cm long (3–5 × 40–100 mm); *V. triptera* has 3-winged fruits to 7 mm wide and 3 cm long (5–7 × 15–30 mm).

Male flowers: male flowers are produced on an axis enclosed in a spathe. They are released as a spherical 'bud' and float to the surface where they open. They have three perianth segments that are normally deflexed and act as floats, and two bisporangiate anthers that are either free or variously fused. The male flowers are of some value when assessing taxa, as they do vary between taxa (see under Discussion). However, they are generally not present on herbarium specimens, are difficult to collect, difficult to relate to living plants, and sometimes variable within the same taxon (see under Discussion).

Female flowers: these are produced in the leaf axils. Each has a long peduncle that allows the flower to reach the surface. The sepals and stigmas are the most obvious features, situated at the apex of the inferior ovary. The flower is white on the first day of opening, turning progressively darker pink as it ages. The free-floating male flowers collect around the meniscus formed by the female flower and pollination occurs when small waves tip the male flowers into contact with the stigmas (Cook 1982). The mature flower is pulled beneath the surface by the tightening spirals of the peduncle whether pollinated or not. There are several useful characters such as the number of perianth segments, the number and degree of fusion of the staminodes, and number, relative size and degree of division of the stigmas (Lowden 1982, McConchie and Kadereit 1987).

Key to species

1 Leaves all cauline; facultative annuals 2

1* Leaves basal, tufted; annuals or perennials 3

2 Fruit 3-winged, trigonous, usually <35 mm long; female flowers with 3 perianth segments ..... **V. triptera**

2* Fruit 2-winged, flattened, usually >40 mm long; female flowers with 2 perianth segments ..... **V. caulescens**

3 Plants facultatively annual (commonly in annual habitats); leaf-tips long-acute; female tufts commonly producing numerous (>12) flowers at maturity in first year while still quite small ..... **V. annua**

3* Plants normally perennial; leaf tips acute or obtuse; female tufts not flowering till plant is several years old and then only producing few flowers (<12) at one time 4

4 Leaf tips acute; filaments in male flower free to fused for about 75% of their length; leaves often <1 cm wide; mostly coastal north of Sydney to the Kimberley ..... **V. nana**

4* Leaf tips obtuse; filaments in male flower fused for about 75% of their length; leaves often >1 cm wide; coastal south of Sydney and inland, sometimes introduced further north ..... **V. americana**

1. Vallisneria triptera *S.W.L. Jacobs & K.A. Frank*, **sp. nov.**

V. caulescenti affinis, sed perianthio 3-partito, fructibus brevioribus latioribus 3-alatisque, differt.

Holotype: Northern Territory: c. 5 km W. of Jabiru, Arnhem Highway, 12°39.19'S 132°48.97'E, *S.W.L. Jacobs 7970*, 5 May 1996 (NSW); female. Duplicates to DNA, MEL, BRI, Z, B, K.

A male specimen was collected from the same locality: *S.W.L. Jacobs 7971* (NSW), duplicates to DNA, BRI, Z, B.

Submerged, dioecious, stoloniferous annual. Roots fibrous. Leaves cauline, alternate to sub-opposite near stem apex where internodes become shorter, 2–9 cm long, 5–12 mm wide, green to red-green, sometimes with a purple tinge; margins finely toothed at least in the upper half; apex acute; 5–7 major longitudinal veins. Male plant with 1 to several inflorescences in each (usually upper) leaf axil; numerous flowers enclosed in a spathe; spathe ovate, 2.5–4 mm long, 2–3 mm diam. Male flowers minute, <0.5 mm

long; perianth segments 3; anthers 2, bisporangiate; filaments appearing fused (like a 'Y'), hairs present on the base of the androecium. Female plant with 1 to several inflorescences in each (usually upper) leaf axil; spathe thin, translucent, 4.6–5 mm long, enclosing 1 sessile flower; apex obtuse. Female flowers 1.2–1.7 mm long; sepals 3, apex acute to obtuse; petals 3, inconspicuous, minute; staminodes 3, inconspicuous; stigmas 3, bifid, deeply divided or cleft, shorter than sepals, 15–25% as wide as sepals, covered with minute filiform papillae. Fruit ovate in outline, trigonous in transsection, 3-winged at margins, 15–30 mm long, 5–7 mm diam, smooth, green to red-brown. Seeds numerous, narrow-ovoid to ellipsoid, 0.6–0.7 mm long, 0.2–0.3 mm diam., with the surface reticulate with oblong to hexagonal cells with ribbed side walls.

Distribution: the Gardner region of north Western Australia and the Darwin & Gulf region of the Northern Territory.

Selected species examined: Northern Territory, Darwin & Gulf: Arnhem Highway, 31 km E of South Alligator River, *Barker 442* /, 13 Mar 1983 (NSW ex AD); between Mt Brockman and Jabiru, *Craven 2353* /, 21 Feb 1973 (BRI, MEL ex CANB); Mt Brockman, *Dunlop 3325*, 21 Feb 1973 (MEL ex DNA); Baralil Creek, Kakadu National Park, *Jacobs 4994* ?, *4995* /, *4996* ?, *5003* ?, *5004* /, *Sainty & K. Wilson*, 15 May 1987 (NSW).

Western Australia: Gardner: Carson River Station, 14 km S of Carson River Homestead, *Fryxell 4139 & Craven* /, 15 May 1983 (MEL ex Dept. of Agric. USA);Mitchell River above Falls, *Jacobs 8041* / 19 May 1996; Airfield Swamp, c. 5 km N of Mining Camspite, Mitchell Plateau, *Kenneally 8043*, 21 Apr 1952 (MEL ex PERTH).

Grows in freshwater ephemeral creeks, waterholes, swamps or billabongs. Flowers Feb-May; fruits Apr-July. Although this species behaves as an annual, it grows in ephemeral habitats, and there is some preliminary suggestion that it may be able to survive for longer periods under cultivation (L. Smith, pers. comm.)

This species is named from the distinctive 3-winged fruit; from the Greek *tri-*, 3 and *-pterus*, winged.

V. triptera is related to *V. caulescens* but differs in the female flowers and fruit being tripartite instead of bipartite.

McConchie and Kadereit (1987) drew attention to the bipartite nature of the female flower of *V. caulescens*, although a third of the specimens they mapped are *V. triptera* with tripartite female flowers. The authors concluded that, although the bipartite female flowers and the cauline leaf arrangement required the expansion of the generic concept in *Vallisneria*, the tripartite male flowers, and other structures in the female flower, best fitted in *Vallisneria* and they wisely decided that more information was needed before changing the generic placement. *V. triptera* reinforces that view with a female flower more like the rest of the genus than that of *V. caulescens* but having other departures such as the winged fruit and the absence of any observed basal rosette. It seems clear that *V. caulescens* and *V. triptera* are closely related, and both are more closely related to other *Vallisneria* species than to species in any other genus. The only exclusive (primitive or derived?) character they share within *Vallisneria* is the cauline leaf arrangement, a character also shared by the florally distinct *Maidenia* (stamen 1, 3-locular) and *Nechamandra* (female flowers sessile with a long delicate hypanthium). On the present evidence it is best to retain both of the cauline-leaved species in *Vallisneria*.

2. Vallisneria annua *S.W.L. Jacobs & K.A. Frank*, **sp. nov.**

V. nanae affinis, sed annua, apicibus longeacutis foliorum, floribus minoribus pluribusque, differt.

Holotype: Western Australia: c. 3 km W of 'Ellenbrae' turn-off, Gibb River road, 15°59.47'S, 127°01.30'E, *S.W.L. Jacobs 8017* 17 May 1996 (NSW); female. Duplicates to PERTH, DNA, B.

A male specimen was collected at the same locality: *S.W.L. Jacobs 8015* (NSW), duplicates to PERTH, DNA, B.

Submerged dioecious stoloniferous annual. Roots fibrous. Leaves basal, to c. 50 cm long, (1.5–)2–7(–10) mm wide, red or reddish green when fresh, marked with red-brown discontinuous longitudinal stripes; margins usually finely toothed; apex long-acute and finely tapering; sometimes with 1 main central nerve or 3–8 longitudinal nerves, although not always obvious. Male plant with usually 1 to several inflorescences in leaf axils; flowers enclosed in a spathe; spathe ovate, (2.7–)7–10 mm long, 2.2–6 mm diam. Male flowers minute, < 0.5 mm long; 3 sepals; 2 bisporangiate anthers; filaments divided obviously very close to the base (like a 'V'), hairs present at the base of the androecium. Female plant with 1-several inflorescences in leaf axils; spathe thin, translucent, 5.5–12(–20) mm long, enclosing one sessile flower. Female flowers 1.4–2.6 mm long; sepals 3; apex obtuse; petals 3, minute and inconspicuous; staminodes inconspicuous or absent; 3 bifid stigmas, shortly divided (or cleft), as long as sepals, almost as wide as sepals, fringed with minute papillae. Fruit narrow-cylindrical, terete in trans-section, 18–35 mm long, 1–2(–3.5) mm diam., smooth, distinctly marked with red-brown narrow stripes. Seeds ovoid to narrow-ovoid, 0.8–1.0 mm long, c. 0.2–0.3 mm diam., with surface sparsely covered in blunt (or rounded) short hairs.

Distribution: grows north from Central Australia (Northern Territory) northwest into north Western Australia, and northeast into Queensland.

Grows in shallow running water or ephemeral pools or billabongs; this is the common species of ephemeral habitats in the warmer parts of the arid and semi-arid. It does also grow in more perennial habitats but it is not clear whether it behaves as an annual or perennial under these conditions. In keeping with many annuals it produces numerous flowers and these usually start appearing while the plant is still small. The truly perennial species usually do not flower for at least the first year. Flowers Dec–Apr, fruits Jan–June.

This species is named for the annual life cycle.

Similar to *Vallisneria nana* but differs by the long-acute finely tapering leaf tips, shorter and narrower fruits, and smaller seeds.

Selected specimens examined: Queensland: Cook: c. 2 km N of the Gulf Development Road on Routh Creek, a right bank tributary of Etheridge River (18°16'S 143°43'E), *Clarkson 2536 & Byrnes*, 10 Aug 1979 ♀ (BRI, MEL); Edward River, *Clarkson 3541A*, 12 Oct 1980, ♀ (MEL ex BRI). Burke: Twelve Mile Creek, 21 km by road N of the Norman River crossing at Normanton (17°32'S 141°07'E), *Aston 2282*, 21 May 1982, ♂ & *2283* ♀ (MEL, BRI); Normanton to Karumba road between Normanton and Maggieville (17°3-'S 141°0-'E), *Clarkson 2698*, 6 Nov 1979, ♀ (MEL, BRI); Kajabbi, Leichardt River, *Jacobs 5920*, 14 Aug 1990, ♀ & *5921* ♂ (NSW); North Kennedy: 0.1 km W of the Burdekin River crossing and 7 km SW of 'Valley of Lagoons' homestead, (18°42'S 145°03'E), *Aston 2300*, 25 May 1982 ♂ (BRI ex MEL); Allingham Swamp, Fletchervale Station, NW of Charters Towers, *Williams 81107*, 14 July 1981 ♀ (BRI). South Kennedy: Kinchant Dam, near Mackay, *Jacobs 4040*, 12 May 1981, ♀ (NSW). Mitchell: Lake Galilee, c. 7 km E of 'Swan Lea' homestead on 'Eastmere' road, *K. Wilson 3542*, *Sharpe & Blaxell*, 1 May 1981, ♀ (NSW).

Northern Territory, Darwin & Gulf: Flying Fox Creek 'Beswick – Mainoru' Road, *Jacobs 1715*, 21 May 1974, ♂ & 1716 ♀ (NSW); Birdie Creek, Kakadu National Park, *Leach 2732 & Cowie*, 18 Apr 1990, ♀ (NSW, MEL ex DNA). Victoria River: Jalabra (Jellebra) Spring Rockhole, eastern Gardiner Range, *Aston 2850*, 12 July 1992, ♂, *2851* ♀ (MEL); Duck Pond Outstation at Merrina Waterhole, *Leach 804*, 5 Sep 1986 ♀ (NSW, MEL ex DNA). Barkly Tableland: Phillip Creek Station, (19°13'S 134°15'E), *Henshall 1035*, 31 May 1975 ♂ (MEL ex DNA); Gold Creek, Wollogorang Station (16°58'S 137°56'E), *Latz 10493*, 9 June 1987 ♀ (MEL ex DNA). Central North: Elkedra Station, Erlpunda waterhole, *Henshall 1756*, 8 May 1977 ♀ (NSW, Mel. ex DNA). Central South: Kings Canyon, (24°15'S 131°35'E), *Latz 9000*, 10 July 1982 ♀ (BRI ex DNA); 3 km N of Kings Canyon (24°12'S 131°35'E), *Latz 8730*, 17 July 1981, ♂ (BRI, MEL ex DNA).

Western Australia: Dampier: c. 21 km downstream of Police Camp Bore, Lennard River, *Jacobs 5600* ♂, *5601* ♀ & *P.G. Wilson*, 11 May 1988, (NSW); 3 km E of Beagle Bay Aboriginal Community, Dampierland Peninsula, (16°58'S 122°42'E), *Kenneally 9484*, 24 Aug 1985 ♂ (MEL ex Perth). Fitzgerald: c. 13 km SE of 'Kimbolton' Homestead, 'Oobagooma' road, *Jacobs 5743* ♂ & *5744* ♀ & *P.G. Wilson* 26 May 1988 (NSW); Traine River, 'Tableland', *Jacobs 4354*, 31 May 1982, ♀ & *4361* ♂ (NSW). Gardner: Drysdale River, at the crossing of the Gibb River – Kalumburu Track, *Fryxell 4860, Craven & J.McD. Stewart*, 19 June 1985, ♀ (MEL ex US Dept. of Agriculture – Cotton Branch Herb.); Lake Argyle, Ord River, *Jacobs 5561* ♀ & *5562* ♂ & *P.G. Wilson*, 8 May 1988 (NSW).

This taxon has been recognised as probably distinct for some years with many of its specimens identified as *V. gracilis* Bailey. There are certain similarities, and the description of *V. gracilis* enhances those similarities. The type of *V. gracilis* though, is a depauperate specimen of the species we are recognising as *V. nana* R. Br. There are still populations in the Little Mulgrave and Mulgrave Rivers (the latter the type locality for *V. gracilis*) that are very similar in all respects to that type. These plants from or near to the type locality are all strongly perennial, produce very few flowers, no fruits have been found and, after cultivation for a few years, grow into plants indistinguishable from *V. nana*.

Vallisneria nana R. Br. (1810: 345)

This name was listed by Lowden (1982) as an unidentified taxon. The few specimens of this taxon that he examined from Australia he placed in *V. spiralis* var. *denseserrulata*. Lowden placed these Australian specimens in *V. spiralis* because the material he examined had the filaments in the male flowers free to the base. We have now examined considerably more material and it is apparent that this species is quite variable in this character (the only species we have found to be so variable), often even within one collection of free-floating flowers, though there is no way of knowing how many individual clones may be represented in such a collection. *Vallisneria spiralis* is a temperate/warm temperate species in its narrowest interpretation. *V. nana* in Australia is tropical/subtropical, being replaced in temperate areas by *V. americana*. From the characters judged important by Lowden (1982), the northern perennial species in Australia seems as closely related to *V. americana* as to *V. spiralis*. We therefore propose to recognise the northern perennial taxon as a distinct species. A problem arises in finding the correct name. Lowden suggests that *Physkium natans* Lour. from 'Indochina' may well be the same taxon as his *V. spiralis* var. *denseserrulata*, but the type is sterile and apparently no male plants of any species of *Vallisneria* have been collected from Indochina (Lowden 1982). It is doubtful whether the true identity of that specimen will ever be known with confidence. The specimen is held at the BM and has 'female' written on the sheet but there are no flowers remaining. There is only one intact leaf tip. The next oldest name that is applicable to our species is *V. nana* R. Br., with the type collected from the Gulf of Carpentaria. Brown's name is earlier than any of the other synonyms suggested for *V. spiralis* var. *denseserrulata* and is the most appropriate name to use for our species, given the uncertainty of the application of the name *Physkium natans*.

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